Using Innovative Technology to Monitor Freshwater Cyanobacteria Harmful Algal Blooms in the North Coast Region

Background:

Cyanobacteria, commonly known as blue-green algae, are natural components of healthy fresh water ecosystems; however, under certain water quality conditions they can rapidly multiply causing nuisance blooms. When these blooms contain toxin-producing species they are termed harmful algal blooms (HABs), which pose health risks to domestic animals, wildlife, and humans. Cyanobacteria HABs (known as cyanoHABs) are occurring with increased frequency and severity around the world, including the North Coast Region.

Efforts to more effectively manage cyanoHABs and their public health consequences will require improved monitoring, assessment, and increased educational outreach. The North Coast Regional Water Board established a Cyanobacteria and Harmful Algal Bloom Monitoring & Response Program (CyanoHAB program) in early 2015 to fulfill these objectives.

Summary of Project:

Benthic blooms originating on the substrate of North Coast streams and rivers are very different from planktonic blooms that originate in lakes and reservoirs. The North Coast Region CyanoHAB program monitoring incorporates the collection of water column samples and algae mat samples; the use of passive, time-integrated samplers (Solid Phase Adsorption Toxin Tracking (SPATT) bags); and the monitoring of other environmental risk factors (water temperature, flow, etc.) associated with nuisance blooms.

Cyanobacteria HABs that occur in lakes and reservoirs are caused by free-floating, planktonic cyanobacteria cells. Measuring cyanoHABs and their associated toxins in lakes and reserviors poses fewer challenges and uncertainties than sampling within streams and rivers. In lakes and reservoirs, the water column is relatively stable and the location of nuisance blooms is more easily identified. Planktonic HABs are readily analyzed using grab water column sample collection and researchers have been studying planktonic HABs for many years since they are common throughout the United States and the world.

Conversely, relatively little research has been conducted on benthic blooms. Understanding benthic HABs and the associated public health risks involves layers of complexity not applicable to planktonic HABs. Factors of complexity include:

- Multiple species of cyanobacteria often colonize a specific reach of a river;
- Each species may be capable of producing various toxins;
- Grab water samples provide only a snap shot in time of water moving through the system;
- Timing and precursors to the release of toxins from benthic cyanobacteria is not well understood.

Since 2015, the North Coast Regional Water Board has focused on monitoring for the protection of public health while collecting data to further understand the habitat, growth, and toxin production of benthic cyanobacteria found in North Coast rivers so as to better understand the exposure routes and risks of these blooms. The traditional method of HAB toxin sampling involves taking a grab water sample at a particular location and specific point in time. This type of sampling captures "free" toxin in the water column (extracellular toxins-released from the cells) and free-floating cyanobacteria cells in which toxins remain bound within the cell walls (intracellular toxins). Benthic cyanobacteria cell colonies attached to the substrate are much less likely to be free-floating in the water column, and thus less likely to be captured in a traditional grab water sample. To capture intracellular toxicity potential Regional Water Board staff collect benthic cyanobacteria mat grab samples. This consists of physically removing cyanobacteria mat material from the stream substrate and placing it in a sample bottle for laboratory analyses. A third method used to sample cyanobacteria toxins is the deployment of passive, time-integrated samplers called SPATT bags; which are mesh bags that contain a synthetic resin which adsorbs toxins to it as the water flows through the bag.

Solid Phase Adsorption Toxin Tracking (SPATT) Bags
Photo Courtesy of Keith Bouma-Gregson

Monitoring results have documented the importance of collecting algal mat grab samples when monitoring in water bodies with benthic blooms. As reflected in the table below, simply measuring cyanotoxins present in the water column may result in underestimating the potential health threat. Algae mat grab sample results provide insight into toxin levels; those toxins bound within cells at risk of release into the water column. These toxin-rich cyanobacteria mats are especially dangerous to dogs, which often preferentially injest mat material thus being exposed to high levels of toxins, which can result in death.

Sample Method	Anatoxin (Neurotoxin)
SPATT	5.062 ng/g
Water Grab	Non Detect
Algal Mat Grab	1217 ug/L

Sample results from the Russian River near Cloverdale Airport – 10/3/2016

In 2017, the North Coast Regional Water Board continued to implement multiple monitoring methods in an effort to better understand toxin dynamics, exposure routes, and risks of these benthic blooms in our river systems. In combination with U.S. Geologic Survey instream telemetry data (temperature and dissolved oxygen), Regional Water Board staff assessed biostimulatory indicators, visual observations, and water column and algal mat toxin results to determine cyanoHAB risks. When monitoring conditions indicated a potential threat to public health, Regional Water Board staff initiated posting of signs at key public access points in the affected water bodies alerting recreational users to take precautions recommended for the protection of public health.

For additional information on these efforts, please contact Katharine Carter at 707-576-2290 or Katharine.Carter@waterboards.ca.gov.